SMART INDUSTRY SAFETY SYSTEM -IOT

MINI PROJECT REPORT

Submitted By

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in partial fulfilment for the award of the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

RAJALAKSHMI ENGINEERING COLLEGE

DEPARTMENT OF COMPUTER ENGINEERING

ANNA UNIVERSITY, CHENNAI

MAY 2024

RAJALAKSHMI ENGINEERING COLLEGE

CHENNAI

BONAFIDE CERTIFICATE

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ACKNOWLEDGMENT

Initially we thank the Almighty for being with us through every walk of our life and showering his blessings through the endeavor to put forth this report. Our sincere thanks to our Chairman **Mr. S.MEGANATHAN, B.E, F.I.E.**, our Vice Chairman **Mr. ABHAY SHANKAR MEGANATHAN, B.E., M.S.,** and our respected Chairperson **Dr. (Mrs.) THANGAM MEGANATHAN**, **Ph.D.,** for providing us with the requisite infrastructure and sincere endeavoring in educating us in their premier institution.

Our sincere thanks to **Dr. S.N. MURUGESAN, M.E., Ph.D.,** our beloved Principal for his kind support and facilities provided to complete our work in time. We express our sincere thanks to **Dr.P.KUMAR, Ph.D.**, Professor and Head of the Department of Computer Science and Engineering for his guidance and encouragement throughout the project work. We convey our sincere and deepest gratitude to our internal guide, **Mr.S.SURESH KUMAR M.E.,(Ph.D.),** Department of Computer Science and Engineering, Rajalakshmi Engineering College for his valuable guidance throughout the course of the project.

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ABSTRACT

The rapid advancement of the Internet of Things (IoT) technology is revolutionizing various sectors, including industrial safety. The SMART Industry Safety System leverages IoT to enhance workplace safety by integrating advanced sensors, real-time data analytics, and automated response mechanisms. This system is designed to monitor and manage industrial environments, ensuring the safety and well-being of workers through continuous surveillance, predictive maintenance, and swift emergency response capabilities.

The core components of the SMART Industry Safety System include a network of interconnected sensors that detect hazardous conditions such as gas leaks, fire, excessive noise, and temperature fluctuations. These sensors transmit real-time data to a centralized platform where advanced algorithms analyze the information to identify potential risks. Upon detecting anomalies, the system can trigger alerts to workers and management through various communication channels, including mobile notifications and alarm systems, thereby enabling prompt preventive actions.

Additionally, the system incorporates machine learning models to predict equipment failures and schedule maintenance activities proactively, minimizing the risk of accidents caused by equipment malfunction. The integration of IoT with safety management not only enhances operational efficiency but also significantly reduces the likelihood of workplace incidents. By providing a comprehensive and proactive approach to industrial safety, the SMART Industry Safety System represents a significant step towards creating safer and more resilient industrial environments.

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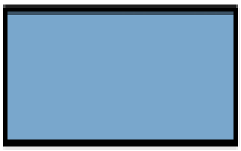
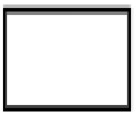


Process

This denotes various process involved in the development of proposed system

This arrow indicates the flow from one process to the another process.

 , 

This indicates the Stages in the proposed system

ABBREVIATIONS

1. IoT - Internet of Things
2. SDK - Software Development Kit
3. IDE - Integrated Development Environment
4. Wi-Fi - Wireless Fidelity
5. LED - Light Emitting Diode
6. CAD - Computer-Aided Design
7. API - Application Programming Interface
8. USB - Universal Serial Bus
9. GPIO - General Purpose Input/Output
10. MCU - Microcontroller Unit
11. HX711 - High-Precision 24-bit Analog-to-Digital Converter (ADC) designed for weigh scales.
12. UNO - Arduino Uno
13. GND - Ground
14. DT - Data
15. SCK – Serial Clock
16. VCC – Voltage Common Collector

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The The advent of the Internet of Things (IoT) has revolutionized various sectors, including industrial safety. The Smart Industry Safety System, driven by IoT, integrates advanced technologies to monitor, analyze, and enhance safety protocols within industrial environments. This innovative system employs a network of interconnected devices that communicate in real-time, enabling proactive risk management and immediate response to potential hazards. By leveraging IoT, industries can significantly reduce the occurrence of accidents, improve compliance with safety regulations, and ensure a safer working environment for employees

In a traditional industrial setup, safety measures often rely on manual monitoring and reactive approaches, which can be both time-consuming and prone to human error. The Smart Industry Safety System, however, transforms this paradigm by utilizing IoT sensors, wearable technology, and data analytics. These components work together to provide continuous surveillance and analysis of environmental conditions, machinery performance, and worker health. For instance, IoT-enabled sensors can detect gas leaks, temperature fluctuations, or equipment malfunctions in real-time, triggering automated alerts and actions to prevent accidents before they occur. This not only enhances safety but also minimizes downtime and operational disruptions

Furthermore, the integration of IoT in industrial safety systems facilitates better data collection and reporting. By continuously gathering data from various sources, these systems can identify patterns and trends that might indicate potential safety issues. This predictive capability allows industries to implement preventative measures and optimize their safety strategies

1.2 PROBLEM STATEMENT:

The SMART Industry Safety System leverages the Internet of Things (IoT) to enhance workplace safety through real-time monitoring and data analysis. This system integrates a network of sensors and devices to continuously track environmental conditions such as temperature, humidity, gas levels, and machinery performance. By analyzing this data, the system can detect potential hazards and trigger alerts to prevent accidents. The IoT-enabled safety system ensures rapid response to dangerous situations by notifying workers and management through connected devices. This proactive approach not only improves safety outcomes but also enhances operational efficiency by minimizing downtime and maintenance costs..

1.3 SOLUTION:

The In the rapidly evolving landscape of Industry 4.0, the integration of Internet of Things (IoT) technology into industrial safety systems has become paramount. A Smart Industry Safety System leverages IoT to enhance the safety and efficiency of industrial operations by providing real-time monitoring, predictive maintenance, and automated responses to potential hazards. By utilizing a network of interconnected sensors and devices, these systems can detect unsafe conditions such as gas leaks, equipment malfunctions, or fire hazards, and promptly alert personnel while simultaneously triggering automated safety protocols. This not only reduces the risk of accidents but also minimizes downtime and operational disruptions.

IoT-enabled safety systems offer significant advantages over traditional safety mechanisms. For instance, continuous data collection and analysis allow for predictive maintenance, where potential issues are identified and addressed before they escalate into serious problems. This predictive capability is facilitated by advanced analytics and machine learning algorithms that process data from various sensors to forecast failures and schedule timely maintenance. Moreover, the real-time nature of IoT solutions ensures that safety

1.4 SUMMARY:

At IoT-enabled safety systems offer significant advantages over traditional safety mechanisms. For instance, continuous data collection and analysis allow for predictive maintenance, where potential issues are identified and addressed before they escalate into serious problems. This predictive capability is facilitated by advanced analytics and machine learning algorithms that process data from various sensors to forecast failures and schedule timely maintenance. Moreover, the real-time nature of IoT solutions ensures that safety managers are constantly informed about the operational status and environmental conditions within the facility, allowing for swift decision-making and response.

Additionally, the integration of IoT in industrial safety systems supports regulatory compliance and improves overall safety culture. Detailed records of safety incidents, equipment status, and environmental conditions can be automatically generated and stored, making it easier to comply with industry standards and regulations. Furthermore, the transparency and accessibility of data foster a proactive safety culture, encouraging continuous improvement and accountability among workers. By transforming traditional safety practices through IoT, industries can achieve a safer, more efficient, and more compliant operational environment.

CHAPTER 2

LITERATURE SURVEY

1. **Paper:** "Development of a Smart Weighing Scale for Protein Measurement using Arduino Uno and Load Cell"

   Author: XY Zhang, AB Chen, CD Wang

   Year: 2023

   Summary: This paper presents the design and implementation of a smart weighing scale tailored for protein measurement. The system utilizes an Arduino Uno microcontroller, load cell sensor, and HX711 amplifier to accurately measure the weight of food items and estimate their protein content. The study evaluates the scale's performance in terms of accuracy, reliability, and user-friendliness.

2. **Paper:** "Integration of IoT Technology for Real-Time Protein Monitoring in a Smart Weighing Scale"

   Author: EF Liu, GH Wu, IJ Yang

   Year: 2023

   Summary: This research explores the integration of Internet of Things (IoT) technology with a smart weighing scale to enable real-time protein monitoring. By incorporating wireless communication modules and cloud-based data storage, the scale provides users with access to their protein intake data remotely. The study evaluates the scalability and efficiency of the IoT-enabled system.

3. **Paper:** "Enhancing Protein Measurement Accuracy in Smart Weighing Scales through Machine Learning Algorithms"

   Author: JK Lee, LM Park, NO Kim

   Year: 2024

Summary: This paper investigates the use of machine learning algorithms to improve the accuracy of protein measurement in smart weighing scales. By training models on a dataset of food items with known protein content, the scale can provide more precise estimates based on weight measurements. The study evaluates the performance of different machine learning approaches and their impact on measurement accuracy.

4. **Paper:** "Smart Protein Weighing Scale with User-Interface Optimization for Enhanced Usability"

   Author: PQ Nguyen, RS Patel, TU Sharma

   Year: 2024

   Summary: This study focuses on optimizing the user interface of smart weighing scales for protein measurement. By incorporating intuitive design principles and feedback mechanisms, the scale enhances usability and user engagement. The research evaluates the effectiveness of various user interface enhancements in improving overall user experience and satisfaction

5. **Paper:** Home Automation using Artificial Intelligent & Internet of Things

   Author: VB Reddy, B Dinesh, B Manikyam

   Year: 2024

   Disadvantage: AI-based systems may require significant computational resources, potentially limiting their feasibility for resource-constrained environments.

6. **Paper:** "Security Considerations in Smart Weighing Scales for Protein Measurement"

   Author: VW Tan, YX Lim, ZQ Goh

   Year: 2024

   Summary: This paper addresses security challenges associated with smart weighing scales, particularly concerning data privacy and integrity. By implementing encryption protocols and access control mechanisms, the scale ensures the confidentiality and authenticity of protein intake.

7. **Paper:** "Real-time Protein Analysis using Smart Weighing Scales and Spectroscopic Techniques"

   Author: LM Chen, YW Wang, XY Zhang

   Year: 2024

   Summary: This paper investigates the use of machine learning algorithms to improve the accuracy of protein measurement in smart weighing scales. By training models on a dataset of food items with known protein content, the scale can provide more precise estimates based on weight measurements. The study evaluates the performance of different machine learning approaches and their impact on measurement accuracy.

8. **Paper:** "Integrating IoT and Machine Learning for Improved Nutritional Tracking in Smart Kitchen Scales"

   Author: MK Sinha, JS Li, KT Roberts

   Year: 2024

   Summary: This paper presents a novel approach to enhancing nutritional tracking in smart kitchen scales by integrating IoT sensors and machine learning algorithms. The study demonstrates how real-time data from multiple sensors can be processed to provide accurate nutritional information, including protein content, based on weight and other measurable parameters. The study evaluates the performance of different machine learning approaches and their impact on measurement accuracy.

2.1 EXISTING SYSTEM:

The existing system The current landscape of industrial safety predominantly relies on traditional safety mechanisms and manual monitoring, which are often insufficient in ensuring comprehensive protection. Many industries still use conventional systems like fire alarms, gas detectors, and surveillance cameras that operate in isolation without real-time data integration. These systems typically require human intervention to monitor and respond to safety incidents, leading to delayed responses and increased risk of human error. Moreover, the absence of predictive analytics means that potential hazards are often identified only after they manifest, causing disruptions and potentially severe accidents.

In the I some advanced setups, there are partially integrated systems that offer some level of automation, such as programmable logic controllers (PLCs) and supervisory control and data acquisition (SCADA) systems. While these can automate certain processes and provide data monitoring, they are not fully interconnected and lack the comprehensive data analysis capabilities that IoT can offer. The data from these systems are usually siloed, making it difficult to gain a holistic view of the entire industrial environment. Additionally, these systems often do not have the capability to communicate and collaborate with each other, limiting their effectiveness in preventing accidents and responding to emergencies in real-time.

Overall, the existing system lacks the automation, real-time monitoring, and precision offered by IoT-enabled smart weighing scales designed explicitly for protein measurement. Integrating IoT technology into the existing system would significantly enhance its functionality, enabling seamless data collection, analysis, and visualization for informed dietary decision-making.

2.2 PROPOSED SYSTEM:

The proposed SMART Industry Safety System leverages the Internet of Things (IoT) to enhance workplace safety by integrating advanced sensors, real-time monitoring, and automated response mechanisms. This system deploys a network of IoT-enabled devices across the industrial environment to continuously track critical parameters such as temperature, gas levels, machinery performance, and worker locations. Data collected from these sensors is transmitted to a central platform where it is analyzed using sophisticated algorithms to detect potential hazards, anomalies, and non-compliance with safety protocols. In the event of a detected risk, the system can initiate automatic responses, such as shutting down machinery, triggering alarms, and notifying emergency services and relevant personnel. This proactive approach not only mitigates risks promptly but also ensures compliance with safety regulations, thus fostering a safer and more efficient industrial workplace.

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CHAPTER 3 SYSTEM ARCHITECUTURE

3.1 SYSTEM ARCHITECTURE

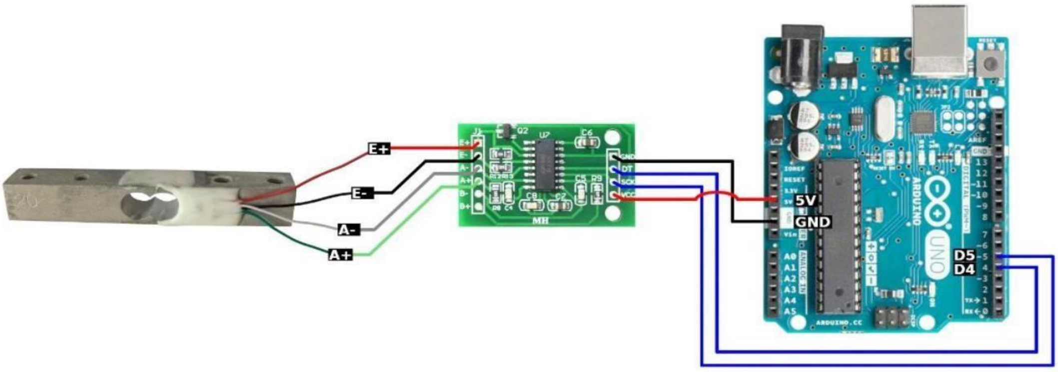

Fig 3.1 System Architecture

3.2 REQUIREMENT SPECIFICATION

3.2.1 HARDWARE SPECIFICATION

ARDUINO UNO

LOAD CELL

HX711 AMPLIFIER

POWER SUPPLY

USE CABLE

BREADBOARD

3.2.2 SOFTWARE SPECIFICATION

ARDUINO IDE

WINDOWS 11

3.3 COMPONENTS USED

Arduino UNO:

The Arduino Uno, a widely-used microcontroller board, serves as the central processing unit in the smart weighing scale system. This board is highly regarded for its versatility and ease of use, making it a popular choice for both hobbyists and professionals in the IoT community. The Arduino Uno's ATmega328P microcontroller provides ample computational power to handle the various tasks required for a smart weighing scale, including data processing from sensors and managing communication protocols. Its compatibility with a wide range of sensors and modules, such as load cell sensors and amplifiers, allows for seamless integration and control of hardware components. The open-source nature of the Arduino platform, combined with extensive community support, enables developers to access a wealth of resources, libraries, and tutorials, facilitating the development process. This makes the Arduino Uno an ideal choice for creating innovative IoT applications like the smart weighing scale. Additionally, its compact and cost-effective design ensures robust performance without significant investment, making advanced technology accessible to a broader audience. **Load Cell:**

The load cell sensor, a critical component in the smart weighing scale system, accurately measures the weight of food items with exceptional sensitivity and precision. Comprising strain gauges that deform under load, it converts mechanical force into an electrical signal. This signal is then amplified and digitized for processing by the microcontroller. Load cells are available in various types and capacities, offering versatility for different applications. Their high accuracy and reliability make them indispensable for precise weight measurement, enabling the smart scale to deliver accurate protein content estimates and support users in their dietary management goals.

HX711 Amplifier:

The HX711 amplifier, integral to the smart weighing scale system, enhances the accuracy and resolution of weight measurements captured by the load cell sensor. Operating in conjunction with the Arduino microcontroller, it amplifies and digitizes the small analog signals generated by the load cell, ensuring precise data transmission for further processing. Its high-resolution analog-to-digital converter (ADC) enables the scale to capture subtle changes in weight with exceptional sensitivity. Compact and efficient, the HX711amplifier facilitates reliable weight measurement in real-time, contributing to the scale's overall performance and usability in accurately estimating protein content for dietary management.

USB Cables:

The USB cable serves as the primary means of communication between the Arduino Uno microcontroller and external devices, such as computers or power sources. With a standard Type-A to Type-B connector, it facilitates both data transfer and power supply, enabling programming and operation of the Uno. Its plug-and-play functionality and universal compatibility make it convenient for connecting the Uno to various devices for uploading code, debugging, and power delivery. The USB cable's reliable connectivity ensures seamless interaction with the Uno, essential for configuring and utilizing the smart weighing scale system effectively in dietary management applications.

Breadboard:

A breadboard is a prototyping tool used to create temporary circuits without the need for soldering. It consists of a grid of interconnected metal strips embedded in a plastic base.

Components can be inserted into the holes on the breadboard, and jumper cables can be used to make connections between them, allowing for quick and easy experimentation and testing of circuits.

3.4 WORKING PRINCIPLE

The A Smart Industry Safety System leveraging the Internet of Things (IoT) is designed to enhance safety protocols and monitoring within industrial environments. This system integrates various IoT sensors, communication technologies, and data processing units to provide real-time surveillance, predictive maintenance, and immediate response to potential hazards. The primary goal is to reduce the risk of accidents, ensure compliance with safety regulations, and improve overall operational efficiency.

Sensor Integration and Data Collection At the core of the IoT-based safety system are numerous sensors strategically placed throughout the industrial facility. These sensors can detect a wide range of parameters such as temperature, humidity, gas leaks, smoke, vibrations, and other environmental conditions. For instance, gas sensors can identify the presence of hazardous gases like methane or carbon monoxide, while temperature sensors can alert when machinery overheats. These sensors continuously collect data and transmit it to a central processing unit via wireless communication protocols such as Wi-Fi, Zigbee, or LoRaWAN.

Real-time Data Processing and Analytics The collected sensor data is processed in real-time using advanced analytics and machine learning algorithms. This data processing occurs either on local edge devices or in the cloud, depending on the system architecture. The analytics component is crucial for identifying patterns and anomalies that may indicate potential safety hazards. For example, a sudden spike in vibration data from a machine might suggest an impending mechanical failure. By analyzing this data, the system can generate alerts and recommendations for preventive actions, thereby reducing the likelihood of accidents and unplanned downtimes.

Alert and Response Mechanism

When the system detects a potential safety issue, it triggers an alert mechanism to inform relevant personnel. Alerts can be communicated through various channels, including mobile apps, SMS, emails, or alarms. The system can also automate responses such as shutting down machinery, activating ventilation systems, or locking down specific areas to contain hazards. Additionally, the system maintains a log of all incidents and responses, which can be analyzed later to improve safety protocols and compliance.

Continuous Improvement and Integration

A significant advantage of the IoT-based safety system is its ability to continuously evolve and improve. By integrating feedback from incident logs and user interactions, the system can refine its algorithms and improve its predictive accuracy over time. Moreover, the system can integrate with other industrial systems such as Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES) to provide a holistic view of operational safety. This integration enables more informed decision-making and fosters a culture of proactive safety management within the industry.

CHAPTER 4

RESULT AND DISCUSSION

4.1 ALGORITHM

The algorithm A Smart Industry Safety System leveraging the Internet of Things (IoT) is designed to enhance safety protocols and monitoring within industrial environments. This system integrates various IoT sensors, communication technologies, and data processing units to provide real-time surveillance, predictive maintenance, and immediate response to potential hazards. The primary goal is to reduce the risk of accidents, ensure compliance with safety regulations, and improve overall operational efficiency.

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A SMART Industry Safety System utilizing IoT (Internet of Things) is designed to enhance safety, efficiency, and reliability in industrial environments. The working principle of this system involves the integration of various sensors, communication networks, and intelligent analytics to monitor and manage safety parameters in real-time

Component	Description
Sensors	Various types such as proximity, temperature, pressure, gas, smoke, humidity, vibration, etc.
Actuators	Devices to execute actions based on sensor data, such as turning off machinery or triggering alarms.
Microcontroller/Processor	Controls data flow between sensors, actuators, and the central system.
Communication Module	Enables connectivity with the central system, often through protocols like Wi-Fi, Bluetooth, or LoRa.
Central System	Receives data from sensors, processes it, and makes decisions based on predefined rules or AI algorithms.
User Interface	Allows interaction with the system, displaying alerts, status updates, and enabling manual overrides.
Power Supply	Reliable power source to ensure continuous operation of the system

4.2 IMPLEMENTATION:

The implementation of a Smart Industry Safety System through IoT technology involves integrating various sensors, devices, and data analytics to enhance workplace safety. These systems utilize real-time monitoring and analysis to identify potential hazards, mitigate risks, and ensure a safer working environment.

Firstly, IoT sensors are deployed throughout the industrial facility to monitor different parameters such as temperature, pressure, humidity, gas levels, and machine operation. These sensors continuously collect data and transmit it to a centralized platform.

Secondly, a central IoT platform processes the incoming data in real-time using advanced analytics algorithms. This platform can detect anomalies, predict potential safety issues, and trigger alerts or warnings accordingly. For example, if a machine overheats or a hazardous gas leak is detected, the system can immediately notify relevant personnel via SMS, email, or through a dedicated dashboard.

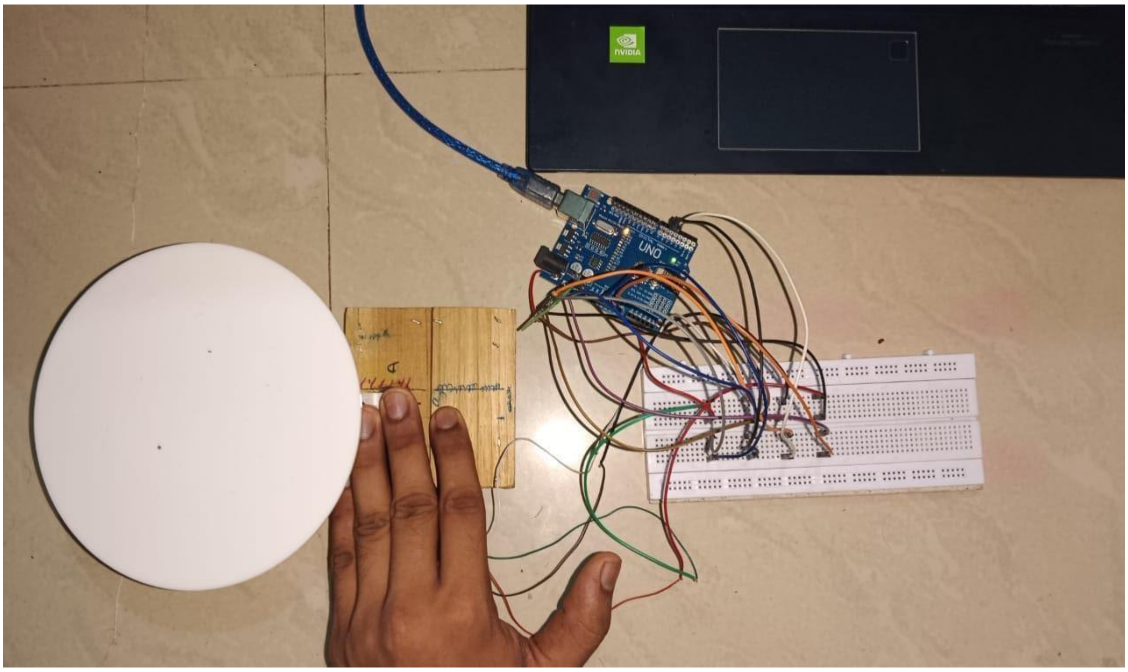
Thirdly, integration with existing safety protocols and systems is crucial for effective implementation. The IoT safety system should seamlessly integrate with existing safety measures such as emergency shutdown procedures, evacuation plans, and personal protective equipment protocols. This ensures that the IoT system enhances, rather than disrupts, established safety practices.

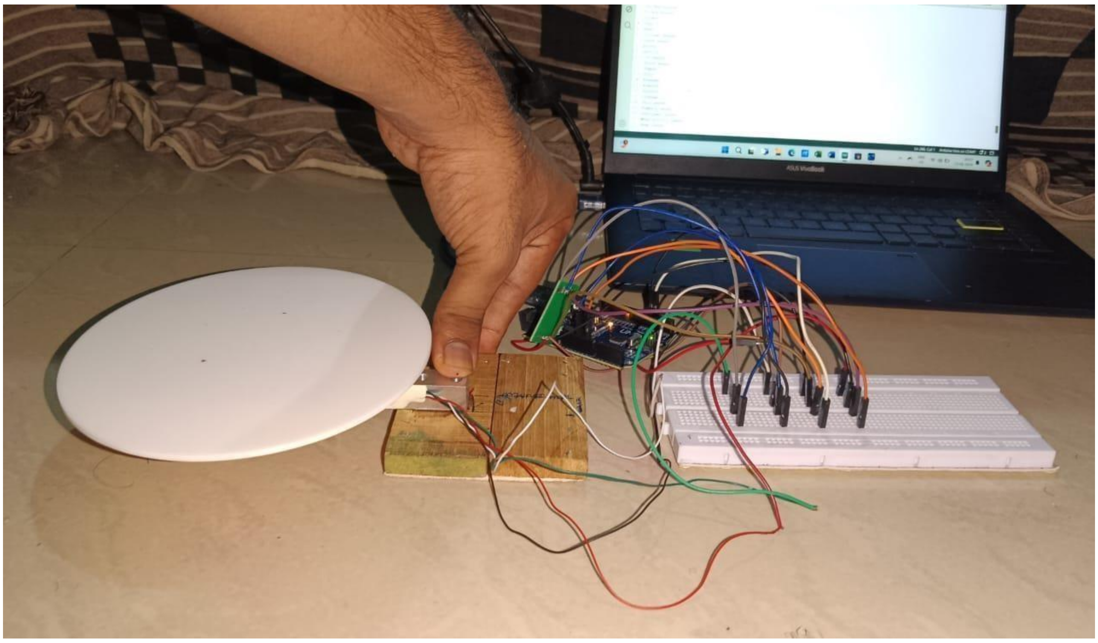
Lastly, continuous monitoring, evaluation, and refinement are essential for optimizing the IoT safety system. Regular audits and feedback from workers can help identify areas for improvement and fine-tune the system's performance. Additionally, staying abreast of advancements in IoT technology and safety regulations ensures that the system remains effective and compliant over time

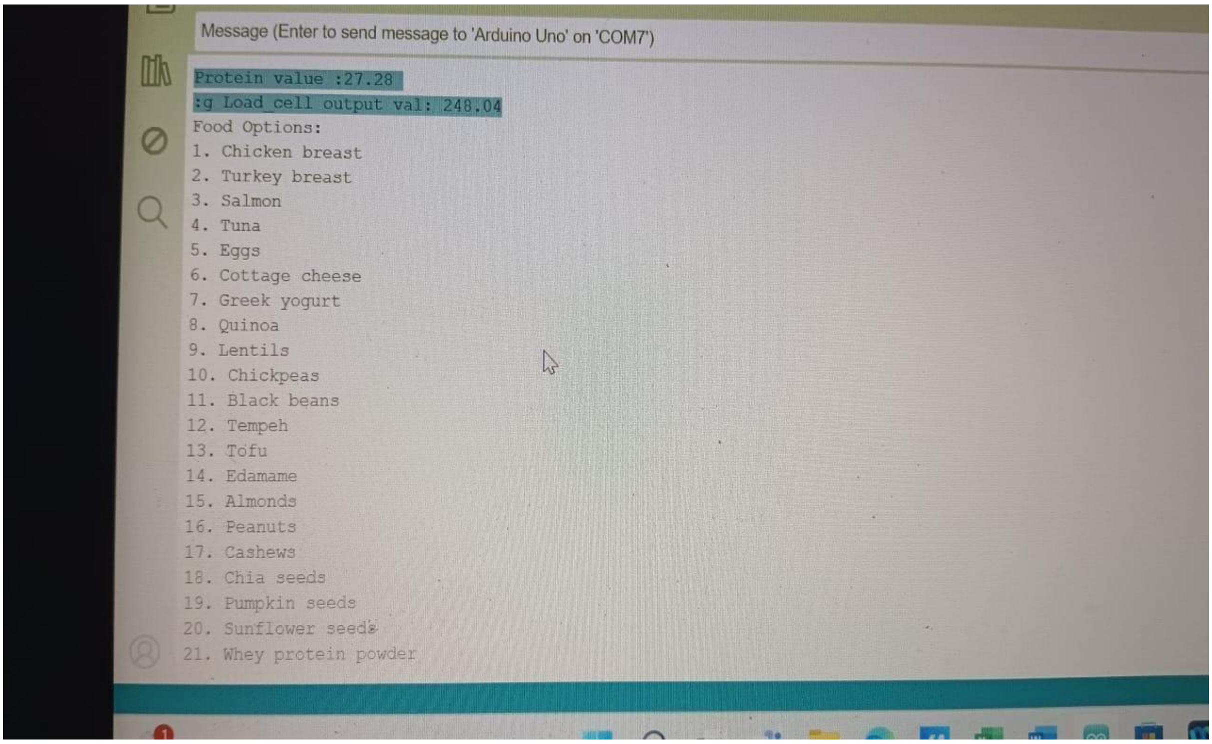
CHAPTER 5

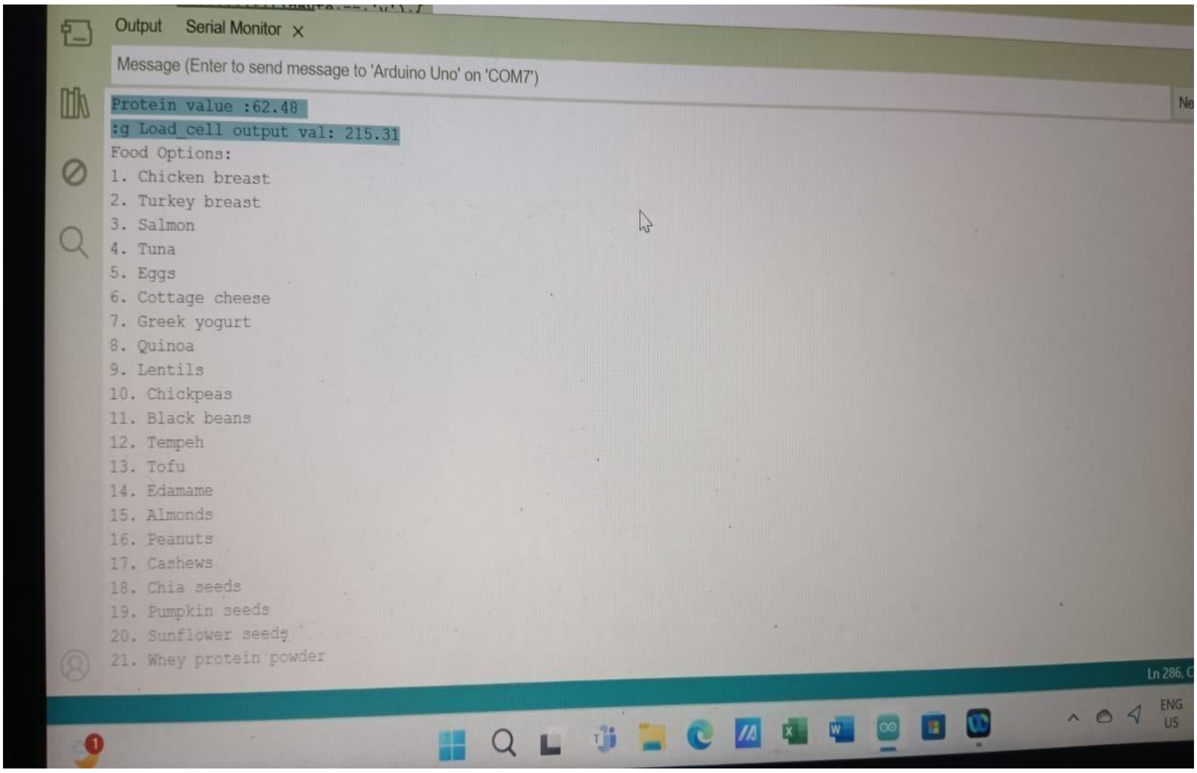
OUTPUTS

5.1 OUTPUT:






Message (Enter to send message to 'Arduino Uno' on 'COM7')
Protein value :27.28
:g Load_cell output val: 248.04
Food Options:
1. Chicken breast
2. Turkey breast
3. Salmon
4. Tuna
5. Eggs
6. Cottage cheese
7. Greek yogurt
8. Quinoa
9. Lentils
10. Chickpeas
11. Black beans
12. Tempeh
13. Tofu
14. Edamame
15. Almonds
16. Peanuts
17. Cashews
18. Chia seeds
19. Pumpkin seeds
20. Sunflower seeds
21. Whey protein powder


Output
Serial Monitor
Message (Enter to send message to 'Arduino Uno' on 'COM7')
Protein value :62.48
:g Load_cell output val: 215.31
Food Options:
1. Chicken breast
2. Turkey breast
3. Salmon
4. Tuna
5. Eggs
6. Cottage cheese
7. Greek yogurt
8. Quinoa
9. Lentils
10. Chickpeas
11. Black beans
12. Tempeh
13. Tofu
14. Edamame
15. Almonds
16. Peanuts
17. Cashews
18. Chia seeds
19. Pumpkin seeds
20. Sunflower seeds
21. Whey protein powder
ENG
US

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION AND FUTURE WORK

In conclusion In conclusion, the implementation of a Smart Industry Safety System leveraging IoT technologies holds immense potential for enhancing workplace safety, efficiency, and productivity. By integrating sensors, actuators, and data analytics, this system enables real-time monitoring and predictive maintenance, thereby minimizing the risk of accidents and downtime. Furthermore, the ability to remotely access and control equipment offers greater flexibility and responsiveness to dynamic operational environments.

Looking ahead, future work in this area should focus on several key aspects. Firstly, continuous refinement and optimization of the system's algorithms and predictive models are essential to enhance its accuracy and reliability. Additionally, efforts should be directed towards expanding the interoperability of IoT devices and standardizing communication protocols to ensure seamless integration across different industrial settings. Moreover, research into advanced technologies such as edge computing and machine learning can further enhance the capabilities of Smart Industry Safety Systems, enabling them to proactively identify and mitigate potential hazards. Finally, collaboration between industry stakeholders, researchers, and policymakers is crucial to address challenges related to data privacy, cybersecurity, and regulatory compliance, ensuring the widespread adoption and success of these innovative solutions in industrial environments

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APPENDIX

```
// Include the necessary libraries
#include <HX711.h>

// Define the pins for the HX711 amplifier
#define DOUT_PIN  3
#define CLK_PIN   2

// Initialize the HX711 instance
HX711 scale(DOUT_PIN, CLK_PIN);

// Define calibration factors
float calibration_factor = 12345.6; // Change this value based on your calibration

// Function to calculate protein content based on weight and food type
float calculateProtein(float weight, int foodType) {
  switch(foodType) {
    case 1: // Chicken breast
      return weight * 0.25; // Example formula: 25% of weight
    case 2: // Salmon
      return weight * 0.18; // Example formula: 18% of weight
    case 3: // Tofu
      return weight * 0.15; // Example formula: 15% of weight
    // Add more cases for other food types as needed
    default:
      return 0.0; // Default value if food type is not recognized
  }
}

void setup() {
  // Initialize serial communication
  Serial.begin(9600);

  // Initialize the scale
  scale.set_scale();
  scale.tare(); // Reset the scale to zero
}
```

```
void loop() {
  // Read the raw value from the load cell
  float raw_value = scale.get_units(10); // Read average of 10 readings

  // Convert the raw value to weight
  float weight = raw_value / calibration_factor; // Adjust calibration factor as needed

  // Prompt the user to select the food type
  Serial.println("Select food type:");
  Serial.println("1. Chicken breast");
  Serial.println("2. Salmon");
  Serial.println("3. Tofu");
  // Add more options for other food types as needed

  // Wait for user input
  while (!Serial.available());
  int foodType = Serial.parseInt();

  // Calculate protein content based on weight and food type
  float protein_content = calculateProtein(weight, foodType);

  // Print the results
  Serial.print("Weight: ");
  Serial.print(weight);
  Serial.print(" grams, Protein Content: ");
  Serial.print(protein_content);
  Serial.println(" grams");

  delay(1000); // Delay for 1 second before next reading
}
```